

Appl. No. : 09/785,944
Filed : February 16, 2001

AMENDMENTS TO THE CLAIMS

1. (Original) A laser for generating ultra-short optical pulses, comprising:
a cavity which repeatedly passes light energy along a cavity axis;
a length of multi-mode optical fiber doped with a gain medium and positioned along said cavity axis;
a pump for exciting said gain medium;
a mode locking mechanism positioned on said cavity axis; and
an optical guide positioned on said cavity axis which confines the light amplified by said multi-mode optical fiber to preferentially the fundamental mode of said multi-mode optical fiber.
2. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said mode locking mechanism comprises a passive mode locking element.
3. (Original) A laser for generating ultra-short optical pulses as defined in Claim 2 wherein said passive mode locking element comprises a saturable absorber.
4. (Original) A laser for generating ultra-short optical pulses as defined in Claim 3 wherein said saturable absorber comprises InGaAsP.
5. (Original) A laser for generating ultra-short optical pulses as defined in Claim 3 additionally comprising a power limiter for protecting said saturable absorber.
6. (Original) A laser for generating ultra-short optical pulses as defined in Claim 5 wherein said power limiter comprises a two photon absorber.
7. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises a single-mode mode-filter fiber on said cavity axis.
8. (Original) A laser for generating ultra-short optical pulses as defined in Claim 7 wherein said single-mode mode-filter fiber is fusion spliced onto one end of said multi-mode optical fiber.
9. (Original) A laser for generating ultra-short optical pulses as defined in Claim 8 wherein said multi-mode fiber is tapered at said fusion splice.
10. (Original) A laser for generating ultra-short optical pulses as defined in Claim 8 wherein said single-mode mode-filter fiber is tapered at said fusion splice.
11. (Original) A laser for generating ultra-short optical pulses as defined in Claim 8 wherein both said single-mode mode-filter fiber and said multi-mode fiber are tapered at said fusion splice.

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12. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said pump is coupled to said multi-mode fiber along said cavity axis.

13. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said pump is coupled to the side of said multi-mode fiber.

14. (Original) A laser for generating ultra-short optical pulses as defined in Claim 13 additionally comprising an optical coupler for coupling said pump to said multi-mode fiber.

15. (Original) A laser for generating ultra-short optical pulses as defined in Claim 13 additionally comprising a v-groove on said multi-mode optical fiber for coupling said pump to said multi-mode fiber.

16. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 additionally comprising a polarization beam splitter for outputting said ultra-short optical pulses from said laser.

17. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said cavity comprises a pair of reflectors at its opposite ends.

18. (Original) A laser for generating ultra-short optical pulses as defined in Claim 17 wherein one of said pair of reflectors is partially reflecting and provides the output for said cavity.

19. (Original) A laser for generating ultra-short optical pulses as defined in Claim 17 wherein said mode locking mechanism comprises a saturable absorber, and wherein one of said reflectors is formed on a surface of said saturable absorber.

20. (Original) A laser for generating ultra-short optical pulses as defined in Claim 19 wherein said mode locking mechanism additionally comprises a power limiter for protecting said saturable absorber, and wherein said saturable absorber is formed on a surface of said power limiter opposite said one of said reflectors.

21. (Original) A laser for generating ultra-short optical pulses as defined in Claim 20 wherein said power limiter comprises a two-photon absorber.

22. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 additionally comprising a linear phase drift compensator on said cavity axis.

23. (Original) A laser for generating ultra-short optical pulses as defined in Claim 22 wherein said linear phase drift compensator comprises a Faraday rotator.

24. (Original) A laser for generating ultra-short optical pulses as defined in Claim 23 wherein said linear phase drift compensator comprises a pair of Faraday rotators.

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25. (Original) A laser for generating ultra-short optical pulses as defined in Claim 22 additionally comprising a linear polarization transformer on said cavity axis.

26. (Original) A laser for generating ultra-short optical pulses as defined in Claim 25 wherein said linear polarization transformer comprises a wave plate.

27. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said mode locking mechanism comprises an active mode locking element.

28. (Original) A laser for generating ultra-short optical pulses as defined in Claim 27 wherein said active mode locking element comprises an optical amplitude modulator.

29. (Original) A laser for generating ultra-short optical pulses as defined in Claim 27 wherein said active mode locking element comprises an optical frequency modulator.

30. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said ultra-short optical pulses preferentially in the fundamental mode of said multi-mode optical fiber have a pulse width below 500 psec.

31. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 additionally comprising an environmental stabilizer on said cavity axis to assure that said cavity remains environmentally stable.

32. (Original) A laser for generating ultra-short optical pulses as defined in Claim 31 wherein said environmental stabilizer comprises a Faraday rotator.

33. (Original) A laser for generating ultra-short optical pulses as defined in Claim 32 wherein said environmental stabilizer comprises a pair of Faraday rotators.

34. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises an optical fiber doped with an amplifying medium to provide gain guiding.

35. (Original) A laser for generating ultra-short optical pulses as defined in Claim 34 wherein said amplifying medium is concentrated centrally within a fraction of the core diameter of said optical fiber.

36. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises a single-mode optical fiber on said cavity axis.

37. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said optical guide comprises a mode-filter on said cavity axis.

38. (Original) A laser for generating ultra-short optical pulses as defined in Claim 37 wherein said mode filter excites the fundamental mode of said multi-mode fiber.

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39. (Original) A laser for generating ultra-short optical pulses as defined in Claim 38 wherein said mode filter excites the fundamental mode of said multi-mode fiber with an efficiency of at least 90%.

40. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said cavity additionally comprises a positive dispersion element.

41. (Original) A laser for generating ultra-short optical pulses as defined in Claim 40 wherein said positive dispersion element comprises a length of single-mode positive dispersion fiber positioned along said cavity axis.

42. (Original) A laser for generating ultra-short optical pulses as defined in Claim 41 additionally comprising an output coupler for limiting the light energy at said single-mode positive dispersion fiber to less than 10% of the peak power in said cavity.

43. (Original) A laser for generating ultra-short optical pulses as defined in Claim 42 additionally comprising a frequency converter for compressing pulses generated by said cavity.

44. (Original) A laser for generating ultra-short optical pulses as defined in Claim 43 wherein said frequency converter comprises a frequency doubler.

45. (Original) A laser for generating ultra-short optical pulses as defined in Claim 44 wherein said frequency doubler comprises chirped periodically poled LiNbO₃.

46. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said multi-mode fiber includes a core, and wherein said gain medium in said multi-mode optical fiber is concentrated centrally within the core of said multi-mode fiber.

47. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said multi-mode optical fiber is polarization-maintaining.

48. (Original) A laser for generating ultra-short optical pulses as defined in Claim 47 wherein said polarization-maintaining multi-mode fiber has an elliptical core.

49. (Original) A laser for generating ultra-short optical pulses as defined in Claim 47 wherein said polarization maintaining multi-mode fiber comprises stress-producing regions.

50. (Original) A laser for generating ultra-short optical pulses as defined in Claim 1 wherein said cavity additionally comprises a fiber grating written onto said multi-mode fiber, said grating primarily reflecting the fundamental mode of said multi-mode fiber.

51. (Canceled)

52. (Canceled)

53. (Canceled)

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54. (Canceled)

55. (Previously Presented) A method of generating ultra-short optical pulses, comprising:
circulating light energy within a laser cavity;
amplifying said light energy within said laser cavity in a multi-mode fiber; and
confining said light energy within said laser cavity substantially to the fundamental mode of
said multi-mode fiber.

56. (Original) A method of generating ultra-short optical pulses as defined in Claim 55
additionally comprising mode locking said light energy.

57. (Original) A method of generating ultra-short optical pulses as defined in Claim 55
wherein said confining comprises mode filtering said light energy.

58. (Original) A mode-locked laser for generating high power ultra-short optical pulses,
comprising:

A multi-mode optical fiber doped with gain material for amplifying optical energy;
means for pumping said optical fiber; and

means for confining the optical energy amplified by said multi-mode optical fiber to
substantially the fundamental mode of said multi-mode optical fiber.